

## Coordinator Notes:

### Module 4.2: Electronics - Circuits

This session explores electronic circuits. Students learn:

- about the importance of electronic circuits in the modern world
- how to draw simple circuit diagrams, including identifying different circuit components

Students use their circuit diagram drawing skills to design a simple circuit, and then a wire loop game as this module's challenge. Students are provided with materials to build and test their circuit designs. Students can choose to build their own designs, or, interpret another groups drawing, and build their design.

#### **Session Length:**

This Module can be presented in different session durations per your needs.

Lesson plans are provided for:

- A 120 minute session, or, 2 x 60 minute sessions
- 45 minute, 75 minute, and 90 minute sessions

#### **Technology:**

**PowerPoint:** If you do not have access to a data projector and cannot display the PowerPoint presentation, we recommend that you print the most important slides before the session, and either enlarge them onto cardboard to use in place of slides, or create a booklet that students can share in small groups.

The session can be conducted without slides, however they offer important visual aid in explanation of circuit components and symbols used for circuit diagrams.

**Videos links:** The suggested links to online videos within the session can be helpful with explanation. Notes have been included in the slides if there is an essential component to a video which the facilitator should discuss or demonstrate, if the video cannot be played.

**Video files:** A video file for each Module has been provided to aid explanation and instruction for some experiments and challenges. It is recommended coordinators view video files prior to delivering sessions, if the experiments and challenge activities are unfamiliar.

**\*Please read the Module 4 Risk Assessment before proceeding with the activity\***

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## Module 4.2: Electronics - Circuits

### Overview

In this session, we explore the concept of circuits. Students learn that all electronic and electrical systems and equipment are built from circuits.

Circuits are composed of: power sources (stored power), conductors (such as wires), and electronic or electrical components that carry out specific tasks (such as lights, switches, bells).

This session builds on the previous module, where we introduced energy types, energy storage, and energy transformation.

#### Content overview:

Concept / Activity	Session Duration (minutes)			
	120	90	75	45
Flow of electrical current through circuits	*	*	*	*
Circuit components: power sources, switches.	*	*	*	*
Circuit complexity: component tasks (turning on lights, making sounds, passing on digitally coded information / instructions)	*	*	*	*
Circuit basics: closed circuits, connections, role of switches	*	*	*	*
Circuit diagrams, standard symbols for components	*	*	*	*
<b>Activity 4.2.1:</b> Designing and drawing a circuit with a working LED light, buzzer, power source and switch. Building the designed circuit from simple materials.	*	*	*	-
<b>Challenge 4.2:</b> Designing and drawing a Wire Loop Game using gained knowledge of circuits and switches.	*	*	*	*

**Slides:**

PowerPoint Slides are available to support the delivery of this module. Slides explain concepts visually, and include short, engaging videos relevant to the topic.

A full list of slides and recommended inclusions for each session duration are provided in the table below. Appropriate slides are also noted in lesson plans for each duration.

<b>PowerPoint Presentation: 'M 4.2 - Master Slides 120 minute Session Duration'</b>		<b>Session Duration (minutes)</b>			
<b>Slide</b>	<b>Content</b>	<b>120</b>	<b>90</b>	<b>75</b>	<b>45</b>
<b>1</b>	Introductory title page for Module 4.2	*	*	*	*
<b>2</b>	Discussion prompt slide: How do lights turn on?	*	*	*	*
<b>3</b>	Overview: Circuits and their components.	*	*	*	*
<b>4</b>	Discussion prompt: Wearable electronic circuits	*	*	*	*
<b>5</b>	Overview: Circuit basics.	*	*	*	*
<b>6</b>	Discussion prompt: Open and closed circuits.	*	*	*	*
<b>7</b>	Overview: Closed circuits.	*	*	*	*
<b>8</b>	Overview: Drawing circuit diagrams.	*	*	*	*
<b>9</b>	Overview: Circuit diagram symbols.	*	*	*	*
<b>10</b>	<b>Activity 4.2.1:</b> Circuit Design	*	*	*	-
<b>11</b>	Introductory page for <b>Challenge 4.2:</b> Wire Loop Game	*	*	*	*
<b>12</b>	Overview: Challenge 4.2 aims	*	*	*	*
<b>13</b>	Examples: Wire Loop Game Designs, discussion prompt.	*	*	*	*
<b>14</b>	Rules and materials overview for Challenge 4.2	*	*	*	*
<b>15</b>	Scoring overview for Challenge 4.2	*	*	*	*
<b>16</b>	References & Resources	*	*	*	*

<b>Module 4.2 Electronics - Circuits</b> <b>Lesson Plan</b> <b>120 minute session or 2 x 60 minute sessions</b>			
<b>High Tech:</b> Use PowerPoint Presentation 'M4.2 - Master Slides'			
<b>Key Learning Area</b> Physics		<b>Topic</b> Circuits	
<b>Timing</b>	<b>Running Time (hh:mm)</b>	<b>Procedure</b>	<b>Materials</b>
<b>3 min</b>	00:03	<b>Lesson Introduction</b> Welcome! Brief recap Module 4.1: energy types, energy storage, energy transformation.  Discussion: how does a light turn on, with just the flick of a switch?	M4.2 PowerPoint (Slides 1-2)
<b>7 min</b>	00:10	<b>Body of Lesson (Lesson 1, 2 x 60 minute sessions)</b> Introduction to circuits.	M4.2 PowerPoint (Slides 3-7)
<b>5 min</b>	00:15	Introduction to drawing circuits.	M4.2 PowerPoint (Slides 8-9)
<b>35 min</b>	00:50	Drawing and constructing a circuit.	M4.2 PowerPoint (Slides 8-10) Planning sheet 4.2.1, pencils/pens, paper clips, split pins/thumb tacks, copper wire, 9V batteries, 9V battery clips, electrical tape, cardboard, buzzers, 5mm LED globes. <i>Optional: Conductive and non-conductive playdough.</i>
<b>5 min</b>	00:55	Introduce Challenge 4.2 Wire Loop Game. Discuss considerations.  <b>(Break for 2 x 60 minute sessions)</b>	M4.2 PowerPoint (Slides 11-13)

		<b>(Lesson 2, 2 x 60 minute sessions)</b>	
<b>2 min</b>	00:02/ 01:02	Recap and discuss the previous session if commencing Lesson 2 on a different day. Who can remember the key features of circuits?	M4.2 PowerPoint (Slides 11-13)
<b>3 min</b>	00:05/ 01:05	Reintroduce Challenge 4.2 and outline rules, materials, scoring.	M4.2 PowerPoint (Slides 14-15)
<b>40 min</b>	00:45/ 01:45	Undertake the Wire Loop Game Challenge.	Planning sheet 4.2, pens / pencils, 9V batteries, battery clips, 9V buzzers, LED Lights (3mm – 5mm), copper wire, electrical tape, thick cardboard / timber / foam for base
<b>10 min</b>	00:55/ 01:55	Testing of games, scoring.	Score sheets 4.2
		<b>Lesson Conclusion</b>	
<b>5 min</b>	01:00/ 02:00	Discussion, questions, clean up.	

### Activity 4.2.1: Circuit Design

**Aim:** To draw a circuit diagram, and construct a circuit from a diagram.

**Materials (per group):**

- 1 x 9V battery and 1 x battery clip
- 1 x 9V buzzer
- 1 LED Light (3mm – 5mm)
- thin copper wire
- Spilt pins / thumbtacks
- Paper clips
- Electrical tape
- Thick cardboard, textas/pens/pencils
- Planning sheet / circuit symbols

**Procedure:**

**Part 1: Design Drawing**

1. In pairs, draw a design for a circuit using the symbols.
2. Share your design with another pair. Can they read and understand the design?
3. Decide if you'll construct your design, or another pair's.

**Part 2: Construction**

4. Draw the chosen circuit diagram / design onto a piece of thick cardboard.
5. Construct your circuit over the diagram. Push split pins/thumb tacks into the cardboard at the corners of your circuit as well as at either side of each component to hold wires in place.
6. Twist wire around the first split pin/thumb tack and run it along to the next pin. Continue to do this around the whole circuit, leaving gaps in the wire where the switch, battery, LED and buzzer will be included.
7. Insert the components by wrapping wire around their terminals and connecting the wire to the neighbouring pins / wires. Tape the wires down with electrical tape. Twist the battery clip wires around pins and clip the battery into the clip.
8. For the switch, attach a paper clip to one of the split pins/thumb tacks which is connected to the wire by pinning over one end of the paper clip. Ensure that the neighbouring pin is close enough for the paper clip to reach it. To operate the switch, move the paperclip, to touch the neighbouring pin and complete the circuit ("ON") or, miss the pin and break the circuit "OFF".

Any breaks, or gaps, in the circuit between wires / components will stop the electrical current from flowing. The circuit, when connected properly, will allow the LED to light up and buzzer to buzz when the switch is closed. The copper wire, split pins/thumb tacks and paper clips are conductive, and allow electricity to flow from the battery, through them to the components (bulb and buzzer). This is a simple way to make circuits without needing to solder wires together.

This activity can be altered, or extended, using conductive and non-conductive playdough.

Visit: <http://www.abc.net.au/science/articles/2012/04/17/3479415.htm>

### Activity 4.2.1: Circuit Design Planning Sheet

Draw a circuit diagram which includes a battery, light, a buzzer and a switch!

Share your design with another group – can they read and interpret your design?



Cell  
(power source)



Light bulb



Switch (off)



Switch (on)



Buzzer



## Challenge 4.2: Wire Loop Game Challenge

### Coordinator notes

#### Scoring:

A scoring mechanism is included so that the element of 'competition' may challenge all students to participate to their fullest. You may remove the scoring system all together if it does not work with your group of students.

When scoring, it is important to only announce who the winning team is. Consider asking how the students might approach the task differently if asked to do it again, or how they might teach the same things they learned during the club to a younger student. It is important to highlight the good strategies of each team.

#### Activity notes:

Students must construct a wire loop game, using their knowledge of circuits. This activity should be completed in teams of 2-3 students.

After construction, the students can then test their designs (and how steady their hands are) by taking turns to thread the wire loop along the wire path without it touching!

- The aim is for students to construct a circuit which becomes closed when a wire loop touches a wire path, sending current to an LED light bulb and buzzer.
- In order for the circuit to be closed all components must be connected together.
- Ensure each group draws and plans their design before starting on construction.
- Encourage students to minimise use of materials and conserve resources.
- In order to reduce the need for students to use of wire cutters, lengths of wire approximately 30 cm and 15 cm should be pre-cut and made available to the groups. Assist students to cut their wire if other sizes are needed.
- Direct students to wrap and insulate their wire loop handle with electrical tape.
- Each group should include an LED light bulb and buzzer into their circuit, to indicate when the wire has been touched and circuit completed. This signals a loss of game.
- Students can use electrical tape, or thumb tacks, to secure their circuit components to the base of the game (cardboard).
- After construction is completed, the students can then test their designs (and how steady their hands are) by taking turns to thread the wire loop along the wire path without it touching!
- A simple idea / design can be reviewed at: <http://www.energizer.com/science-center/steady-hand-game>

#### Rules

- You must include an LED light bulb and a buzzer in your game.
- Only one 9V battery can be used.

**Materials (per group)**

- 1 x 9V battery and 1 x battery clip
- 1 x 9V buzzer
- 1 LED Light (3mm – 5mm)
- Thin (bare) copper wire, pre-cut into 30cm and 15cm strips (approx. 60cm per group)
- Electrical tape
- Thick cardboard / timber / foam for base
- Planning sheet / circuit symbols, pens/pencils

**Scoring:**

- Groups receive points for:
  - drawing their design prior to construction
  - including both an LED light globe and a buzzer
  - having a functioning game, i.e. the buzzer and/or light turns on when the wire loop touches the wire path
- Groups receive bonus points if... they can complete their own game successfully (without setting off the buzzer and light). Note: ensure / test the circuit is connected up properly before you observe the game!
- Groups receive additional bonus points if... they can complete another team's game successfully!

## Challenge 4.2: Wire Loop Game Planning Sheet

Draw a picture of your wire loop game design. Can you draw it as a circuit diagram?

Remember: the wire loop you hold to play, is one end of the circuit!  
When the wires touch, the circuit is completed. The wire loop acts the same way a switch does in other circuits.

## Challenge 4.2: Wire Loop Game Score Sheet

Team Name	
POINTS AVAILABLE:	POINTS SCORED
Design drawn prior to construction (25 points)	
LED <u>and</u> buzzer included (25 points)	
Wire loop game functions correctly (max 50 points) <ul style="list-style-type: none"> <li>• LED turns on: (25 points)</li> <li>• Buzzer turns on: (25 points)</li> </ul>	
BONUS POINTS:	
Successfully complete own game, no buzzing or lights (5 points per team member, maximum 20 points)	
Successfully completes another teams game, no buzzing or lights (5 points per team member, maximum 20 points)	
<b>Final Score:</b>	

Team Name	
POINTS AVAILABLE:	POINTS SCORED
Design drawn prior to construction (25 points)	
LED <u>and</u> buzzer included (25 points)	
Wire loop game functions correctly (max 50 points) <ul style="list-style-type: none"> <li>• LED turns on: (25 points)</li> <li>• Buzzer turns on: (25 points)</li> </ul>	
BONUS POINTS:	
Successfully complete own game, no buzzing or lights (5 points per team member, maximum 20 points)	
Successfully completes another teams game, no buzzing or lights (5 points per team member, maximum 20 points)	
<b>Final Score:</b>	

<p align="center"><b>Module 4.2 Electronics - Circuits</b></p> <p align="center"><b>Lesson Plan</b></p> <p align="center"><b>90 minute session</b></p>			
<p><b>High Tech:</b> Use PowerPoint Presentation 'M4.2 - Master Slides'</p>			
<p><b>Key Learning Area</b> Physics</p>			<p><b>Topic</b> Circuits</p>
Timing	Running Time (hh:mm)	Procedure	Materials
3 min	00:03	<p><b>Lesson Introduction</b></p> <p>Welcome! Brief recap Module 4.1: energy types, energy storage, energy transformation.</p> <p>Discussion: how does a light turn on, with just the flick of a switch?</p>	M4.2 PowerPoint (Slides 1-2)
5 min	00:08	<p><b>Body of Lesson</b></p> <p>Introduction to circuits.</p>	M4.2 PowerPoint (Slides 3-7)
3 min	00:11	Introduction to drawing circuits.	M4.2 PowerPoint (Slides 8-9)
25 min	00:36	Drawing and constructing a circuit.	<p>M4.2 PowerPoint (Slides 8-10)</p> <p>Planning sheet 4.2.1, pencils/pens, paper clips, split pins/thumb tacks, copper wire, 9V batteries, 9V battery clips, electrical tape, cardboard, buzzers, 5mm LED globes.</p> <p><i>Optional: Conductive and non-conductive playdough.</i></p>
4 min	00:40	Introduce Challenge 4.2 Wire Loop Game. Discuss considerations.	M4.2 PowerPoint (Slides 11-15)
35 min	01:15	Undertake the Wire Loop Game Challenge.	<p>Planning sheet 4.2, pens / pencils, 9V batteries, battery clips, 9V buzzers, LED Lights (3mm – 5mm), copper wire, electrical tape, thick cardboard / timber / foam for base</p>

<b>10 min</b>	01:25	Testing of games, scoring.	Score sheets 4.2
<b>5 min</b>	01:30	<b>Lesson Conclusion</b> Discussion, questions, clean up.	

<b>Module 4.2 Electronics - Circuits</b>			
<b>Lesson Plan</b>			
<b>75 minute session</b>			
<b>High Tech:</b> Use PowerPoint Presentation 'M4.2 - Master Slides'			
<b>Key Learning Area</b> Physics			<b>Topic</b> Circuits
<b>Timing</b>	<b>Running Time (hh:mm)</b>	<b>Procedure</b>	<b>Materials</b>
<b>3 min</b>	00:03	<p><b>Lesson Introduction</b></p> <p>Welcome! Brief recap Module 4.1: energy types, energy storage, energy transformation.</p> <p>Discussion: how does a light turn on, with just the flick of a switch?</p>	M4.2 PowerPoint (Slides 1-2)
<b>3 min</b>	00:06	<p><b>Body of Lesson</b></p> <p>Introduction to circuits.</p>	M4.2 PowerPoint (Slides 3-7)
<b>3 min</b>	00:09	Introduction to drawing circuits.	M4.2 PowerPoint (Slides 8-9)
<b>20 min</b>	00:29	Drawing and constructing a circuit.	<p>M4.2 PowerPoint (Slides 8-10)</p> <p>Planning sheet 4.2.1, pencils/pens, paper clips, split pins/thumb tacks, copper wire, 9V batteries, 9V battery clips, electrical tape, cardboard, buzzers, 5mm LED globes.</p> <p><i>Optional: Conductive and non-conductive playdough.</i></p>
<b>3 min</b>	00:32	Introduce Challenge 4.2 Wire Loop Game. Discuss considerations.	M4.2 PowerPoint (Slides 11-15)
<b>30 min</b>	01:02	Undertake the Wire Loop Game Challenge.	Planning sheet 4.2, pens / pencils, 9V batteries, battery clips, 9V buzzers, LED Lights (3mm – 5mm), copper wire, electrical tape, thick cardboard / timber / foam for base

<b>8 min</b>	01:10	Testing of games, scoring.	Score sheets 4.2
<b>5 min</b>	01:15	<b>Lesson Conclusion</b> Discussion, questions, clean up.	



<b>Module 4.2 Electronics - Circuits</b>			
<b>Lesson Plan</b>			
<b>45 minute session</b>			
<b>High Tech:</b> Use PowerPoint Presentation 'M4.2 - Master Slides', hide slide 10.			
<b>Key Learning Area</b> Physics			<b>Topic</b> Circuits
<b>Timing</b>	<b>Running Time (hh:mm)</b>	<b>Procedure</b>	<b>Materials</b>
<b>2 min</b>	00:02	<b>Lesson Introduction</b> Welcome! Discussion: how does a light turn on, with just the flick of a switch?	M4.2 PowerPoint (Slides 1-2)
<b>2 min</b>	00:04	<b>Body of Lesson</b> Introduction to circuits.	M4.2 PowerPoint (Slides 3-7)
<b>3 min</b>	00:07	Introduction to drawing circuits.	M4.2 PowerPoint (Slides 8-9)
<b>3 min</b>	00:10	Introduce Challenge 4.2 Wire Loop Game. Discuss considerations.	M4.2 PowerPoint (Slides 11-15)
<b>25 min</b>	00:35	Undertake the Wire Loop Game Challenge.	Planning sheet 4.2, pens / pencils, 9V batteries, battery clips, 9V buzzers, LED Lights (3mm – 5mm), copper wire, electrical tape, thick cardboard / timber / foam for base
<b>5 min</b>	00:40	Testing of games, scoring.	Score sheets 4.2
<b>5 min</b>	00:45	<b>Lesson Conclusion</b> Discussion, questions, clean up.	

## Module 4.2 - References

Circuits:

<http://education.abc.net.au/home#!/media/1478139/light-up-a-light-bulb>

<https://science.howstuffworks.com/environmental/energy/circuit.htm>

<http://education.abc.net.au/home#!/media/2190951/how-electricity-works>

<http://www.electrickids.com.au/wps/wcm/connect/ElectricKids/ElectricKids/Home/Lesson3>

Playdough circuits:

<http://www.abc.net.au/science/articles/2012/04/17/3479415.htm>

Drawing Circuits:

<https://k8schoollessons.com/drawing-circuits/>

Wire Loop Game:

<http://www.energizer.com/science-center/steady-hand-game>

<http://www.miniscience.com/projects/BUZZWIRE/index.html>

## Module 4.2- Required Materials

- Pens, pencils and writing paper are generally required every session.
- Students may like to bring a note pad to record their observations and ideas.
- A group usually refers to 2 - 4 students.

Activity	Material	Amount	Where can I find it?
All sessions	PowerPoint Slides* (digital, or printed)	1 per coordinator	Coordinator Package
All sessions	Printed PowerPoint* Slide Notes	1 per coordinator	Coordinator Package
All sessions	Printed Lesson Plan	1 per coordinator	Coordinator Package
All sessions	Printed Module 1 Risk Assessment	1	Coordinator Package
All sessions	Computer, Data Projector, Screen	1	Venue
<b>Activity 4.2.1</b> Circuit Design All sessions except 45 minute duration	9V Battery	1 per group	Supermarket, hardware store
	9V Battery clip	1 per group	Online, electronics store
	9V Buzzer	1 per group	Online, electronics store
	LED lights (3mm or 5mm)	1 per group	Online, electronics store, automotive store
	Split pins / thumbtacks	6 – 10 per group	Supermarket, hardware store
	Paper clips	2 – 3 per group	Supermarket,
	Thin copper wire	~30cm per group	Hardware store
	Electrical tape	2 rolls	Hardware store
	Thick cardboard	1 piece per group	recycled
Planning sheet	1-2 per group	Coordinator notes	

**Materials List continues on next page**

\* PowerPoint Slides have been provided as a Master Slide Set for a 120 minute (or 2 x 60 minute) session duration. Hide/ omit slides as noted in lesson plans for delivery of shorter session durations.

Note: Materials used in Activity 4.2.1 should be recycled for use in Challenge 4.2.

Activity	Material	Amount	Where can I find it?
<b>Challenge 4.2</b> Wire Loop Game Challenge  All sessions	9V Battery	1 per group	Supermarket, hardware store
	9V Buzzer	1 per group	Online, electronics store
	LED lights (3mm or 5mm)	1 per group	Online, electronics store, automotive store
	Electrical tape	2 rolls	Hardware store
	Thin copper wire	~ 60 cm per group	electronics / hardware / automotive store
	Thick cardboard / timber / foam	1 – 2 pieces per group for base	Recycled, hardware store, supermarket

### Online Shopping Links:

LED Lights (Approx. \$5 - \$10 for 50 lights)

<https://core-electronics.com.au/5mm-led-pack-50-pcs.html>

<https://www.jaycar.com.au/5mm-red-led-pack-pk-100/p/ZD1690>

Copper Wire (approx. \$5 per 7m)

[https://www.bunnings.com.au/tic-7-7m-x-20g-picture-hanging-copper-wire\\_p3930102](https://www.bunnings.com.au/tic-7-7m-x-20g-picture-hanging-copper-wire_p3930102)

Buzzers (from \$2):

<https://core-electronics.com.au/small-enclosed-piezo-w-wires.html>

<https://www.jaycar.com.au/mini-piezo-buzzer-3-16v/p/AB3462>

<http://www.altronics.com.au/hardware/buzzers/>

Battery Clips (from \$0.65):

<https://core-electronics.com.au/9v-battery-clip.html>

<https://www.jaycar.com.au/9v-battery-snap-high-quality/p/PH9232>